CARNIVOROUS PLANT NEWSLETTER

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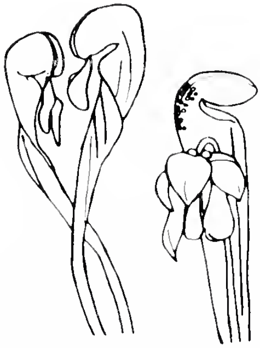

CARNIVOROUS PLANT NEWSLETTER

Official Journal of the International Carnivorous Plant Society

Volume 17, Number 3
September 1988

Front cover: *Dionaea muscipula* grown by Peter D'Amato. Photo by Charles Powell II. Please see article beginning on page 80.

Rear cover: *Utricularia sandersonii* grown and photographed by Charles Powell II.

The co-editors of CPN would like everyone to pay particular attention to the following policies regarding your dues to the ICPS.

All correspondence regarding dues, address changes and missing issues should be sent to ICPS c/o Fullerton Arboretum, CSUF, Fullerton, CA 92634. DO NOT SEND TO THE CO-EDITORS. Checks for subscriptions and reprints should be made payable to ICPS.

All material for publication, comments and general correspondence about your plants, field trips or special noteworthy events relating to CP should be directed to one of the co-editors. We are interested in all news related to carnivorous plants and rely on the membership to supply us with this information so that we can share it with others.

Views expressed in this publication are those of the authors, not necessarily the editorial staff.

Copy deadline for the December 1988 issue is September 1, 1988.

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NEWS & VIEWS

ALEX MRKVICKA (Hopflerg. 6/16, 1230 Vienna, Austria) has sent us some information on his success in cultivating various CP outdoors in his mountainous location near Vienna. His outdoor bog is 4-5 m. across and he has been rather astonished with winter survival.

He is growing the following species: *Drosera rotundifolia, D. intermedia, D. anglica, Pinguicula vulgaris, P. alpina, Sarracenia purpurea purpurea, Dionaea* and some Utricularias, *Darlingtonia* and *Aldrovanda.*

His garden is situated about 40 km west of Vienna where the average temperature in January is —2° C and in July 17° C. The winter temps briefly reach as low as —25° C and summer temps to 32° C. His growth period is roughly from the end of March to mid-October. Snow is on the ground about 60 days a year and averages 0.5-0.7 m. deep.

The *Sarracenia* does very well, retaining pitcher leaves over winter and flowering each spring although without seedset so far (pollination?). *Dionaea* loses all leaves over winter but these regrow in the spring from the rhizome. They do set seed with some seedling activity.

Alex would like to correspond with other cold region growers in middle Europe. He plans to try additional *Sarracenia* and *Droseras.*

GORDON C. SNELLING (427) W. Highland Ave.; Sierra Madre, CA 91024) writes:

Even though most of us have never met, we are bound together by our love for a strange lifeform we call "C.P."

We come together to share information and plants, and compete with each other at shows, yet our greatest concern is the continued existence of our beloved C.P.

I have been a member of this unique fellowship for several years now and have really enjoyed it, and also learned a great deal from it.

However, there has been one thing which has been bothering me, and that is the point I'd like to address today.

The view we like to have of ourselves is as conservationists, as we will go out of our way to save an endangered species, or to prevent the draining of a bog. Some of our more affluent members have actually purchased their own bogs while others of our number must be content to grow in their own yards or greenhouses, yet with all this we fail to see how we may be contributing to the extinction of these ourselves, and I'm not talking about habitat destruction or wild collections.

I've noticed a disturbing (at least to me) trend to push, push, push, hybrid plants. The companies I regularly deal with always have a fair selection of hybrid plants and our own seedbank has a large stock of hybrid seed. So why do we hybridize?

Some people may see dollar signs, hybrids tend to sell for a higher price than non hybrids.

In other cases people may get a sense of accomplishment by producing some new hybrid, I would personally feel I've accomplished something when I successfully propagate a rare or endangered species, at that point I feel like I've really contributed something. Still others may

Please see **SNELLING** on page 67.

FOR THE RECORD

A document by Bob Hanrahan was inadvertently inserted in the last issue (pages 52-54) that was a very early, rough, incomplete and partially inaccurate draft that was submitted in 1985 as a concept review copy for our editorial staff. We sincerely apologize for this oversight and recommend that you read the complete and informative article; "Comments on Conservation From The Owner of A Commercial CP Nursery" in the June, **1986** issue of CPN.

SNELLING continued from page 67
do so because the resulting offspring can be quite spectacular and you never know just what you'll end up with. I'll be the first to admit, some of these plants are quite attractive, but when I buy a plant it's for what it is not what it's been turned into.

However, my basic reason for disliking hybrids is this, the day is fast approaching when for various reasons a good many species of C.P. will be extinct in their natural habitat, and the only remaining plants will be in our collections, however, if we've been devoting all of our energies to creating new hybrids and reproducing these species in their pure forms, well it only takes one accident and a species joins the ranks of extinction.

I've heard it said that when we hybridize a species that later becomes extinct, no matter "At least we've saved the genes." This was actually considered to save a small sparrow native to Florida, fortunately the plan was discarded because enough people realized that no matter how much backcrossing is done the bird would always be a hybrid. The same applies to plants, no matter how much you backcross and how much the offfspring resembles the original parent it will always be a hybrid, and we will have saved nothing.

I'm not saying everybody is out just cranking out hybrids with no thought of anything else, and I know that there are a lot of people just as concerned about this as I am, but I've seen this trend before and I've seen where it leads and I don't want it to happen to us also.

Now I can't tell you not to hybridize, but if you must, at least do it responsibly, keep good records, don't allow hybrids to go unlabled and get mixed with pure species and above all devote some time to reproducing your other specimens in their pure forms.

We've voluntarily taken on the responsibility to see that these unique forms of life don't disappear, and we should do everything in our power to live up to it.

If this has made you think, good, it was supposed to, if not I'm sorry. However, I look forward to a continuing relationship with all of you even if we never meet.

For those of us serious about growing C.P. one of our major goals is the reproduction of the various species in our collections.

Unfortunately, in many cases the seeds of many species are very tiny and difficult to work with. So for those of you who have been frustrated time and again by the tedium of handling small seeds, I've got a solution which I hope may be of some help.

Among my interests, one is entomology, I collect insects. One device commonly used by entomologists to collect specimens too small to be collected by hand is called an aspirator.

This device consists of a small bottle, a #5 rubber stopper with two holes, a metal or glass tube with a 45° angle in it, this tube is about eight inches long, and a smaller (about 4 inches) metal tube also with an angle in it, topped with ten to twelve inches of latex tubing.

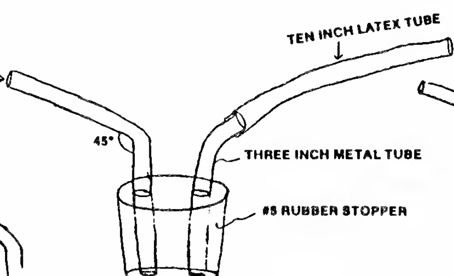


FIG. 1
ASPIRATOR HEAD

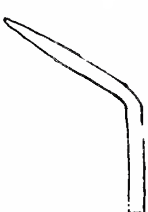


FIG. 2
GLASS INTAKE TUBE
END NARROWED

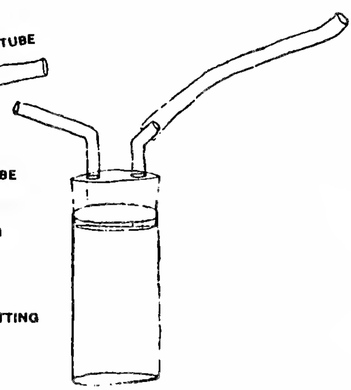


FIG. 3
COMPLETE ASPIRATOR

SNELLING continued

The two metal tubes are inserted into the stopper, the larger tube is your pickup tube which is placed near the items to be collected, and the latex tube will be the tube through which you will inhale (GENTLY) to draw the seeds into the collecting bottle. At this point I should mention, it's a good idea to have a piece of very fine cloth netting over the opening of the inhalation tube to prevent getting a mouthful of seeds. I have found this to be a fast and effective way of handling small seeds.

As can be seen by the accompanying diagram, it is a relatively easy device to construct. The needed components are readily available from most biological supply houses, or it may be ready made from a few specialty supply houses, my favorite being Bio Quip Products in Gardena, California. Call or write for their catalog.

This is a very versatile item which can easily be modified to fit your needs. One modification which I feel to be of particular value is the use of a glass intake tube narrowed at the mouth, this will provide greater control while picking up small items and help prevent picking up small pieces of unwanted debris.

The address of Bio Quip for anyone interested is: Bio Quip Products Inc. 17803 LaSalle Ave., Gardena, Calif. 90248.

GLEN TORIBIO (74 Akron Road, Ephrata, PA 17522) writes: This might sound cracy, but I have been using Lysol® Deodorizing Cleaner to get rid of mildew and fungus on my *Nepenthes.*

I have been growing my plants in a plate glass case 24 inches wide x 59 inches long x 27½ inches deep, with the pots suspended over one inch of water. The medium I am presently using is pure tree fern fiber. Previously I had been using osmunda. For lighting I have a 4 lamp fluorescent light fixture time-switched on a 15/9 hour cycle, which is hinged at the back to make a lid. There is also a humidifier time-switched to be on for one hour, three times a day. It was previously switched to be on four times a day, but I think it was unnecessary. I feed them ants and fireflies and spray them with a dilute fertilizer every so often (fish emulsion or Peter's).

My plants have done magnificently well in these conditions. My collection includes *N. alata, N. rafflesiana, N.* x *Chelsonii, N.* x *Hookeriana, N.* x *Dyeriana, N. kampotiana* x *mirabilis,* and *N. ventricosa* among others.

Somewhere along the line, I noticed mildew on some parts of the plants, especially on those pitchers hanging down near the water level. I do not know what possessed me to experiment with Lysol®, but it works! I have even cleaned the peristomes with no ill effects to the plants. I just soak a Q-tip® or rag with it (full strength!) and wipe the mildew off. This keeps the affected part mildew-free for a long time. I also used it to clean fungus from a new addition to my collection.

There have been no adverse reactions in the plants at all, and I even suspect, at this point, that Lysol® encourages side-shoot production when a node is treated with it.

Did I hear someone laugh? Try it (cautiously, of course).

PATRICK VERDAVAINE (13 Rue Thiers, F-59230 St. Amand-les-Eaux, France)

I have three suggestions for CPN:

An index for all previous issues of CPN since 1972, with the same presentation as found in an issue. It would facilitate our bibliographic research.

A binding base for three or four volumes of CPN. A base protects better than a standard binding.

A slide bank. It would be interesting to be able to get carnivorous plant slides, particularly color slides of CP in the wild condition.

(Ed. note: We welcome any comments from our readers on the above issues. The editors are too busy with editorial duties to take on added responsibilities at this time. Anyone who is interested in persuing a project should submit to us a financial and feasible plan to carry out the project.)

Carnivorous Plants in Micronesia

by Robert R. Ziemer
2220 Elizabeth Road, McKinleyville, CA 95521

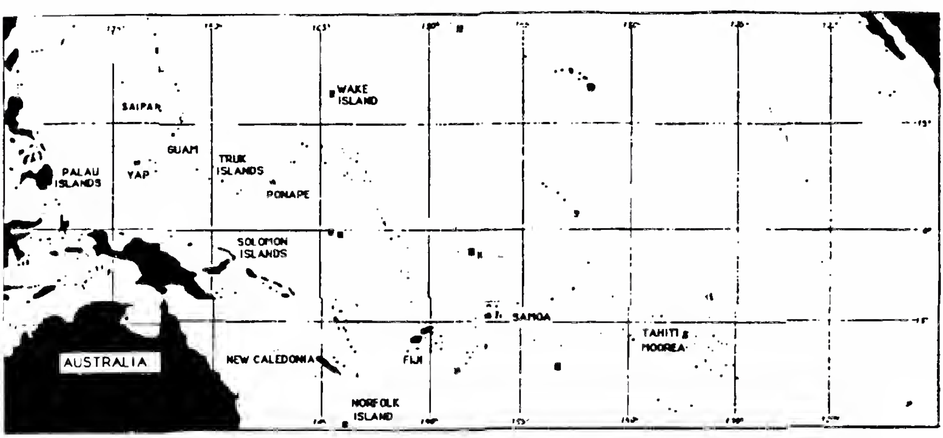
Micronesia encompasses about 2,100 islands scattered over some 12 million sq km of the central Pacific between Hawaii and the Philippines. Only about 125 of these small islands are inhabited. The total land area of Micronesia is less than 3,200 sq km, about the size of the state of Rhode Island. The largest island is Guam, with an area of about 540 sq km. There are four primary island groups, or archipelagos: Gilberts, Marshalls, Carolines, and Marianas.

In December I worked on six of these islands, from west to east: Koror and Babeldaop in the Republic of Palau (or Belau), Yap in the Federated States of Micronesia (FSM), Saipan in the Commonwealth of the Northern Marianas, U.S. Territory of Guam, and Pohnpei in the FSM. *Nepenthes* have been reported only on the western-most islands—Palau (1,200 km north of Biak, Indonesia and 700 km east of Mindanao, Philippines) and Yap (400 km east of Palau and 870 km southwest of Guam).

Micronesia was colonized by people from southeast Asia over 3,000 years ago, first through the Marianas, then the western Carolines. There was much trade among the islands. Yap was the trading center. Stone moneg, quarried on Babeldaop, was transported the 400 km to Yap by canoe. In 1929, there were over 13,000 of these circular stone "coins" on Yap—some over 4 meters in diameter. Today about half survive and are still used for important purchases. The value of each piece is based not so much on its size, but on its age and history.

Micronesia was "discovered" by Europeans about 450 years ago. Much of the area was first claimed and occupied by the Spanish. Germany entered the area in the mid-1800's and, following the Spanish-American War, Spain sold all of her possessions to Germany in 1899. The Germans began to conduct several botanical inventories of the islands. Serious "botanizing" of the islands began after Japan took possession from Germany in 1914. From 1929 through 1935, a Japanese botanist, Ryozo Kanehira, collected and inventoried the plants in Micronesia. Since the 1950's, Francis Fosberg, Sidney Glassman, and Lani Stemmermann have been the principal botanists in Micronesia, and their publications are mentioned below.

There are a number of reasons for the limited amount of botanical work that has been done in Micronesia. The islands are numerous, remote, and cover a vast oceanic region. The tropical climate makes field work in the dense jungle difficult, although many of the more



noxious diseases and insects found in other parts of the tropics are missing. The most important reason, however, probably has been the strategic military importance of Micronesia. By 1920, Japan had begun a vigorous program of economic development and colonization of the islands of the Japanese Mandate. In 1940, two-thirds of the population of Micronesia was Japanese. Following World War II, all remaining Japanese were removed to Japan. Travel to and within Micronesia has been, until recently, severely restricted. Until the 1960's, all travel to Micronesia required a U.S. military security clearance. In the late 1960's, a flood of Peace Corps volunteers were sent to some parts of Micronesia. Even today, some of the islands remain off-limits to non-military personnel, including about one-third of the U.S. Territory of Guam. Despite this, however, tourism is rapidly becoming a mainstay of much of the Micronesian economy. Continental Airlines has regular service on the Honolulu-Majuro-Pohnpei-Truk-Guam-Yap-Koror route. Additional areas are served by other carriers. But, most of the outer islands remain very isolated.

The variety of species encountered in the Pacific islands declines as you move from the Asian mainland. Hawaii, for example, has only 1/2 to 1/3 as many species as is found in Palau. Fosberg, et al. (1979) listed the presence of *Nepenthes mirabilis* in the Palau group on Babeldaop, Koror, Ngarakabesang, Malakal, Aulupse'el, Urukthapel, and Orokuiza; and in the Yap group on Yap. *Drosera burmannii* and *D. spathulata* were found only on Babaldaop. *Utricularia bifida* was reported on Babeldaop and Koror, Yap, and Guam; *U. caerulea* on Babeldaop and Guam; *U. racemosa* on Koror; and *U. ulginosa* on Babeldaop. Stemmermann and Proby (1978) have published detailed location maps of their vegetation sites. Their paper also contains photographs of *U. bifida* and *U. nivea* on Palau, and *N. mirabilis* on Yap. It would be interesting if someone were to take a detailed look at the

***N. mirabilis* on Yap Island, December, 1987. Photo by author.**

distribution of carnivorous plants in Micronesia, and study the genetic diversity within those species found. The gene pool of the CP which colonized each island may well have been represented by only a few individuals, that is, the genetic variants that dispersed to these islands were limited.

The *Nepenthes mirabilis* that I observed was very common in open fields and waste areas in Palau and Yap. In some cases, the plants were growing in barren, heavily eroded "badlands." The origin of the grasslands is the subject of some debate. One view is that they are natural features. The prevailing view is that they were formed and are maintained by the fires that are set annually. Burning the grasslands is a cultural phenomenon that predates European influence. Many people hold the view that the area of grassland is enlarging, and, as erosion reduces soil depth and fertility, the barran areas are also enlarging. In one large and particularly gullied badland area that I observed on Yap, the only vegetation present was scattered *Nepenthes mirabilis* and the fern *Gleichenia linearis*. [A similar phenomenon involving *Nepenthes* has been observed in Malaysia, in Sabah. —Ed (TLM)]

The plants that I observed were healthy-looking and green in color, with occasional pitchers having some subdued red coloration, despite growing in the full, unshaded, tropical sunlight. They were 15 to 20 cm in height, many in various stages of flowering.

On Palau, *N. mirabilis* is called "Meliik"; on Yap, it is called "Youaad", or more commonly, "tafene fii ko borro", literally "the place that rats pee." It is thought that the pitchers contain rat urine, perhaps because of the odor of decaying insects. One of the local village employees of the Yap Institute of Natural Sciences who accompanied me in the field was surprised that there was water in the new, unopened pitchers, and wondered how it got

Close up of female *N. mirabilis* on Yap Island. Photo by author.

there. He was also amazed at the collection of dead insects that we found when the open pitchers were sliced. I was also told that the local people occasionally chew the *Nepenthes* seed pods, which reportedly taste like tobacco.

I found Micronesia to be a delightful place. A visit to Yap is like a step 50 years back in time, except for the color TV (tapes of programs are shipped from Los Angeles, complete with LA ads—the news is 1 to 2 weeks old when broadcast in Yap). On the outer islands, the modern world continues to have little effect, and the culture is basically intact. Micronesia was a pleasant reprieve from my home for the past four months—Waikiki Beach, Honolulu. Life is tough all over!!

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Completion of the Fuqua Conservatory in the Atlanta Botanical Garden

by Donald Schnell
(Rt. 1, Box 145C, Pulaski, VA 24301)

About 21 years ago when I was serving a portion of my military service at Fort McPherson in Atlanta, I recall visiting one of the municipal parks called Piedmont Park. Off in one corner was a small greenhouse about the size of the average home greenhouse crammed with assorted plants, and around it a modest lawn and outdoor plantings. As I recall, this was managed for the municipal park system by a garden club. Things were not to remain so.

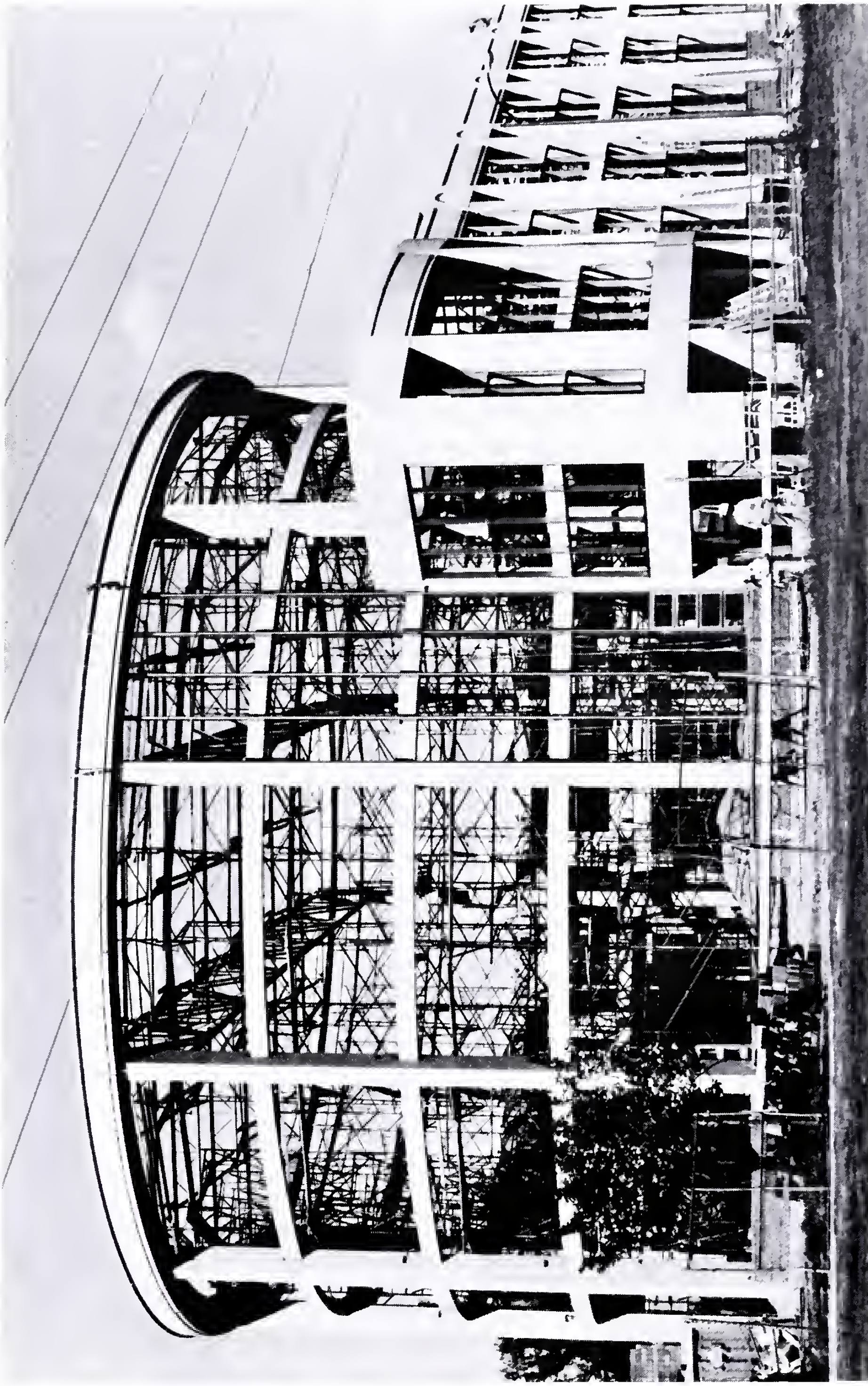
In 1977, the Atlanta Botanical Garden was created as a non-profit organization and they leased 60 acres of the rundown park and began to put together what promises to be one of the most interesting botanical gardens in the United States.

While driving through Atlanta this past spring on one of those point A to point B legs of a botanizing trip, we stopped off at the garden on a hunch and were quite surprised by what we saw. Approximately 15 acres are under management as either well conceived and cared for outdoor plantings or native plants. A 15 acre wooded area has a good trail system. There is a garden entrance building of good size which contains a botanical library, gift shop, classrooms and a large auditorium across a courtyard.

But the object that really caught Brenda's and my collective eye was the towering superstructure of the future conservatory. By complete coincidence, on arriving home a week later, a packet of information on the Garden and the new conservatory was in my mail.

The conservatory is being built with a 5 million dollar donation from a local businessman. An additional bond program for 5-6 million will be sought to appropriately complete the grounds around the 15 or so acre site that will be dominated by this new glass and concrete structure. One of the things mentioned repeatedly in the material I received was

Please see **FUQUA** on page 75



that there would be a collection of 300 or more carnivorous plant species! The overall greenhouse supervision will be under Ron Determann, an ICPS member well known to many of us.

The conservatory will be basically centered architecturally around three tall cylinders 50 feet tall and 88 feet across. Each of these will be devoted to a major habitat condition. The tropical "cylinder" will have *Nepenthes* (many rare) in hanging baskets. The total square footage of the conservatory will be 16,000 (including special display areas under glass in addition to the cylinders), along with a 2200 square foot service building. The non-*Nepenthes* CP will be housed in special conditions behind protective glass in one of the special exhibit areas.

When we were visiting this past spring, the sign said opening would be "late 1988," but a date of March, 1989 has been more realistically penciled into my information packet sheets. Considering Ron's experience with growing CP and managing the University of Florida greenhouses before coming to Atlanta, I believe we can expect something special. Those with interests extending beyond CP will find palms, ferns, orchids, bromeliads, succulents, etc., all in appropriate display and environment. Plants are being gathered now and grown in other greenhouses awaiting transfer to the new facility.

So, if you are near Atlanta after March, 1989, I think it would certainly be well worth your while to visit this garden and its new conservatory. It is easily located in Piedmont Park in northeast Atlanta and is approachable from either I-85 coming in from the north, or I-75/I-85 passing through the city. Good maps of the State show a sufficiently detailed Atlanta map with the park clearly marked. For additional information, write Atlanta Botanical Garden, PO Box 77246, Atlanta, GA 30357 (Phone 404/876-5858).

Tropical Rotunda of the Fuqua Conservatory now under construction at the Atlanta Botanical Garden. The building will feature carnivorous, tropical and endangered plants from around the world and is scheduled to open in March 1989. Photo: Fred Bley

International Carnivorous Plant Society

SEED BANK

June 24, 1988

Capsella bursa-pastoris (15)-non CP; *Byblis liniflora* (10); *Darlingtonia californica; Dionaea muscipula; Drosera aliciae* (5); *D. burkeana* (5); *D. burmannii* (7); *D. capensis* (narrow leaf); *D. capillaris* (4); *D. erythrorhiza; D. filiformis filiformis* (10); *D. glanduligera; D. intermedia; D. intermedia* (Carolina giant) (5); *D. rotundifolia* (10); *D. spathulata* (rotundate) (5); *D. stolonifera stolonifera* (6); *Polypompholyx multifida* (5); *Sarracenia alata; S. leucophylla; S. minor* (5); *S. purpurea* (15); *S. purpurea purpurea* (5); *S. rubra wherryi* (7); *S. alata* x *minor* (4); *S.* x *areolata; S. flava* x *(alata* x *flava); S. rubra* x *oreo* (1); *Utricularia lateriflora* (5); *U. subulata* (5); *U. uliginosa* (4); *U. violacea* (3).

DROSERA PAUCIFLORA
Queen of Sundews

by Peter D'Amato
P.O. Box 1372, Guerneville, CA 95446 (707) 869-3641

In March of 1987, I was given a pot of sundews marked *Drosera cistiflora* and *Drosera pauciflora* from a grower who received the plants from South Africa. It was obvious which of the plants was the former, as the stem was several inches high. Hugging the ground was the second plant, a rosette, which looked so much like the early rosetted stage of *D. cistiflora* pictured in Kondo's Carnivorous Plants of the World in Color on page 26, that I wasn't sure if it was the mysterious *pauciflora* or *cistiflora* in early growth. The grower didn't know either, and I found nothing in the literature available to me to help me out.

As the plants were growing in a small four inch pot, I removed them. I was surprised that the *pauciflora* roots were an incredible twenty-two inches in length, wrapped around and around the pot's interior, similar to other South African species like *D. capensis,* and rather thick. I cut off some of the roots, and transplanted them and the plant into a large twelve inch shallow pot, laying the roots a couple of inches under the mix of peat and sand. Then the following month the rosette shriveled and died. I rightfully assumed this South African plant had a similar growth cycle as some other winter growing sundews, dying back to its roots for a summer resting period. Since the roots were so long, it seemed to me that in the wild they probably grew deep into the moist soil where they grew, while the soil surface dried out to some extent. So I let the pot sit and kept it just damp, and kept my fingers crossed as well.

Four months went by, and then in August the first plants broke the soil surface, and I set the pot in a tray of water. I was pleased to see that it put up mature rosettes, and within six weeks I had a good dozen plants, each about three inches across, some a little larger. The leaves are pale green and strapped-shaped, semi-erect until they come to rest and hug the dead leaves below. The tentacles are also pale green, surmounted by a red gland. The marginal tentacles are among the most developed I have seen, and move with alarming speed upon prey, and the whole leaf folds over as does *D. cistiflora* and *D. capensis.* They easily catch insects as large as houseflies.

Drosera pauciflora forms a thin black wirey stem as it grows. The rosette "crawls" along the soil surface, the rosette moving several inches away from where it first broke through, and new roots anchor it to the ground from the trailing stem. Other plants suddenly appear from the extensive roots, and one finally has a cluster of spreading plants with intertwined stems and roots lying close to the soil surface.

As handsome as the rosettes are, and as interesting as the growth habit may be, it was nothing compared to the events that occured around November of that year, four months after the plants first emerged.

It was then, during the cool winter with temperatures about 60F during the day and in the 40s at night, that the first flower scapes appeared. Each scape had between one and four buds on it, and the scape stretched to between 12 and 15 inches above the rosettes and were covered with fine sticky glands. There was one scape per plant and my anticipation grew as the first flower approached opening. From the size of the bud, I thought it would be a good sized flower about an inch across. I was in for a surprise.

On a cool morning in late November, I opened my greenhouse door and I almost fell over! The first flower had opened, and to this day it is the most spectacular sight my carnivores have ever greeted me with. The flower was an astounding 2¾ inches across. The petals of this variety were wedge shaped and of a pale pinkish-lavendar, with a shiny ebony ovary that was bulbous and nearly half an inch across. The filaments of the stamens were also black and surmounted by brilliant arrow-head shaped anthers of a startling sulfer yellow, a beautiful contrast to the jet-black background. The five styles were pink, about an inch in length, and topped with feathery stigmas.

Photo by CARL CELLUCCI

As though boasting its beauty, the flower continued to open until the petals were reflexed way back to the scape, so its sexual parts thrust forth in an almost obscene manner. Viewed in profile, this flower is a sight one does not soon forget.

Like many *Drosera* flowers, it opens for one day only. Mine opened at dawn, the petals are totally reflexed by mid-day, and by three o'clock in the afternoon the flower rapidly shrivels and closes. In two or three days the second flower blooms, followed in a few days by the third, and then the fourth. If there is one, each succeeding flower is smaller in size, about two inches across.

Pollination is easy, due to the size of its parts. I have observed hover flies go crazy over the pollen, clinging to the stamen filaments and eating the pollen grains from the anthers with such speed that I have had to shoo them away and pollinate it if not done so immediately by the insects. The flower rapidly closes upon pollination.

My plants flowered from November until March. Only one plant sent up two scapes. It takes a very long time for the seed to mature, the scapes blackening and falling over as the rosettes continue to grow. It appears that the seed actually matures from four to six months after pollination in a small capsule when the plants die back for the summer dormancy. I have heard from one European grower that sometimes the plants will continue to grow without dying back at all. I am assuming that the seed should have a brief resting period, sowing the fine, dust-like seed in Autumn. According to European plant lists I have seen, other color forms exist beside the lavendar, such as white and what must be a truly startling scarlet. I would be interested in hearing from other growers who have had experience growing this species, one of the best droseras now in cultivation.

I will be sending the seed to the ICPS seed bank. Please inquire of the seed bank for its availability.

If *Drosera regia* has been called the king of sundews for the size of its leaves, I think it appropriate to consider *Drosera pauciflora* its queen for the spectacular show of its flowers.

A Varying Lighting Scheme and Its Effects on Some Easily Grown CPs

by Barry Rice
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One of the more popular ways of raising CP's inexpensively is under fluorescent lights in small terraria. A 20 gallon terrarium, equipped with two double-bulbed fixtures can immediately create conditions suitable to a wide variety of plants. The largest difficulty with this arrangement is achieving adequately intense light levels while maintaining low temperatures.

The last few years I have been experimenting with variations on this scheme, and have a few valuable tips and preliminary results for the space conscious grower. It should be noted that since different growers will do things differently, what may work for one won't necessarily work for another. Although this is certainly a function of the grower's experience and technique, some of this inconsistency may arise from the materials used—variations of the heat output even from one fluorescent fixture to another can be substantial. However, here are a few guidelines and experiences.

First, the light sources must of course be fluorescent, as incandescent lights produce far too much infrared (heat) radiation. Another grower (De Franco, 1987) has recently reported success using various arc-lamps, and I am following his lead with varying degrees of success. The ballasts for all the light sources should be remoted by the proper gauge wire to decrease heat conduction to the terrarium. In order to minimize light losses, a reflecting material should be used on all terrarium surfaces except the viewing side(s). The best material I've found for this is aluminum coated mylar because it has a very high reflectivity. You can buy it at hobby shops, and it is also available seasonally as wrapping paper for a customized look. If you intend to use this, make sure that it is mylar and not just wrapping foil. Keep the side without any patterns as the reflective surface. Some cheaper forms of mylar have a aluminized layer that is not thick enough, and allow some light losses. You can look for this by seeing if you can see a bright light source through the film. The thicker material is better.

Aluminum foil is an adequate alternative. Aluminum of course does not tarnish. Somewhat more difficult to find are silvered surfaces. Unless the silver is coated with a protective film, it tarnishes, reducing its reflectivity, which is normally comparable if not slightly better than aluminum. Its chief advantage is that silver is a good absorber in the infrared, and so allows some unwanted radiation to escape through the terrarium walls. However, silver's disadvantages in practice outweigh this bonus.

Even using fluorescent lights with remoted ballasts, the heat produced by the bulbs via thermal losses and infrared radiation is considerable. I have found that during a sixteen hour photoperiod, the temperature inside the terrarium can easily exceed 38° C (100° F). While many plants, especially the rosetted sundews, don't mind this (probably from being close to the cooler moist ground), the taller plants such as *D. filiformis* and *binata* varieties get burnt, as do the scapes of *D. capensis*. This may be reduced by increasing the relative humidity by completely sealing the terrarium, but I haven't tried this yet for fear of promoting fungal growth.

An alternative method for decreasing the maximum temperature is by altering the photoperiod. Using a simple programmable 24-hour timer, I have been experimenting with simulating a sixteen hour photoperiod with an alternation of two hours of light, followed by one hour of darkness—repeated continuously. This resulted in the temperature of the terrarium ranging from the ambient 22° C (72° F) to a high of only 30° C (86° F). Here it must be emphasized that while other growers attempting to duplicate this will probably encounter

different temperature ranges, the overall temperature decrease should be significant. During the winter months the number of light to dark hours are changed to simulate the changed number of daylight hours.

The alternating light/darkness cycle has been in effect now for more than six months, and the results on the plants are now visible. The strange photoperiod is not without effect on the plants. There is of course less burning, and the taller plants nearly grow right up against the bulbs. However, some of the plants are behaving oddly. The rosetted sundews, such as *D. capillaris* and *spathulata*, typically send out flowering scapes much sooner in the plant's development. Many of the plants are only 1.5-2 cm in diameter when they form scapes, half the size they were before the alternating light cycle was adopted. While the plant's flowers used to regularly open and close the same times every day, now they open and close at any point during the day, indicating that they do not have a memory as to when "day" occurs. Although there are many scapes and flowers, the seed production has decreased dramatically in these two species. The viability of the seeds that have been produced has not been tested.

The only other two species of plants showing possible adverse effects to the altered photoperiod are *D. intermedia* and *U. subulata*. The *intermedia* plants grow very nicely to a large size, but the flowers refuse to open, although they do produce limited seed. Since the implementation of the new light cycle, the *subulata* has stopped flowering, except for cleistogamous flowers.

In the coming months it will be interesting to see if the northern plants will respond to a simulated winter. In the past I have successfully induced hibernation in the plants by slowly decreasing the photoperiod. The plants may form hibernacula, or they may try to grow continuously. If the latter, they will probably exhaust and die, in which case the plants can always be propagated by seed or leaf cuttings from the few remaining leaves.

In summary, the species of plants that I have tested can be grouped into two classes. Class I contains the four species mentioned above, which are those that show some (possibly negative) side effects to the staggered light period. Class II contains plants apparently oblivious to the change, and includes the following: all *Sarracenia*, *D. filiformis* (all forms), *D. binata* (all except *multifida*, which I haven't tested), *D. rotundifolia*, *D. capensis*, *D. pulchella*, *D.* 'Lake Badgebup White Flower', *U. longifolia*, *Dionaea muscipula* and *Cephalotus*. The *Pinguicula* in this group are *caerulea*, *lutea*, *primuliflora*, *planifolia*, *ehlersae*, and *moranensis*. I have also propagated all of the Class I, II plants by leaf cuttings partially buried in sphagnum (which also grows well) except for *P. planifolia* and the two pygmies which I'm working on presently. I don't specifically try to propagate the *Utricularia*, but rather am forced to weed it because it is so prolific and weedy. *D. adelae* is also probably a Class II plant, as it shows no dramatic changes. However, since the change they have been developing more long, ropy roots that tend to resurface and form new plants. This is behavior that I've seen before, and the apparent increase in this activity may merely be an indication of the improved environment.

Since nearly all of the plants tested can be propagated by some means or another, I would suggest that growers having high temperature problems in their terraria experiment with some of these optimization techniques, or ones of their own. The results can be very rewarding, and are usually interesting. I would like to hear from other growers and of their results.

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The Electrochemical Mechanism of Trap Closure in *Dionaea Muscipula*

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Dionaea muscipula, the most spectacular of all carnivorous plants, has drawn an amazing amount of attention since its first description by John Ellis in 1770. It is also the uncontested favorite of our visitors who can't resist putting their probing fingers into the traps. Little do they know how damaging this may be to the plant as the following story relates.

The general mechanisms of *Dionaea* closure were studied by Charles Darwin in 1875 and Burdon-Sanderson more than a century ago (Williams, S.E., 1973), and simply described many times (Pickard, 1973). Despite advances in electrophysiology over the past 30 years, detailed knowledge of the trap closure is largely hypothetical.

The first requirement for an effective trap is speed; the speed to detect the prey's presence, the speed to inform the "motor tissues" and the speed to close the trap. However, the transmission of messages in plants is notoriously slow. In a number of species, some cells acquired a structure which is well known from animal cells, namely, the *excitable membrane* (Guyton, 1966, p.58; Vander *et al.*, 1970, p. 134). All cells, whether plant or animal, are surrounded by a membrane which carries enzymes and other proteins responsible for the control of secretions, mutual recognition, permeability, etc. The main difference between regular and excitable membranes is that the latter are capable of functioning in two very different modes depending upon the electrical charge they carry. They possess, as it were, two settings. Other cell membranes are also electrically charged but cannot be excited (Guyton, 1966, p. 58).

How does a membrane become charged? Membranes have the property of gaining or losing certain chemical ions, namely the positively charged potassium ions (K^+) and to a lesser degree the negative chloride ion (Cl^-). As the K^+ is much more abundant inside the cell than outside; it will tend to leak out and the cell will lose positive charges and become negative. After a time, the cell negativity becomes so strong that it prevents further K^+ from leaving (the negative cell attracts the positive ions). An equilibrium will be reached with the inside of the cell becoming negative. This is called the *resting potential* (Guyton, 1966, p. 59; Boriss & Libbert, 1984, p. 310), of about —80 mV in a sensory cell (Benolken & Jacobson, 1970 cited CPN 1:9 (1972). Any leak of negative ions will be balanced by more K^+ ions leaving and thus the resting potential remains steady.

The driving force for K^+ ion movements is the difference in the intracellular and extracellular concentrations which together with the permeability of the ion, defines the actual value of this resting potential (Jacobson & Stuart, 1974 cited in CPN 4:20 1975). The membrane is now *excitable* and perceives changes in its environment so that any physical or chemical stimulation can switch the membrane to the activated mode.

The *epidermal cells* of the trap all possess excitable membranes and repeated stroking of the external epidermis will cause an electrical response which makes the trap more sensitive when sensory hairs are stimulated (Sibaoka, 1966; Di Palma *et al.*, 1966). Earlier writers denied this reactivity of the abaxial epidermis (Lloyd, 1942, p. 188). Although rough handling is necessary to observe a reaction, the slightest touch to a sensory hair will provoke closure and is considered to be the true trigger for trap closure.

It is the special structure of the sensory hair that is responsible for the low sensitivity threshold. The distal part is a long lever which amplifies any minor force such as a tiny insect brushing against it. Below the lever portion are the thick-walled sensory and podium cells with a thin portion indented around the rosette of sensory cells. When the lever is moved, the thick walls will hardly budge, but all the forces will be concentrated on the thin portion (Haberlandt, republished 1982), and the underlying excitable membrane of the sensory cell will switch to its activated state (Benolken & Jacobson, 1970).

A very light stimulus will have only minimal effects on the membrane: the permeability to K+, although decreased, will always remain greater than the permeability to Cl—. The cell will lose some of its resting potential, but as soon as the potassium permeability has returned to normal, a massive outflow of K+ will restore normal cell negativity. Such a transient and partial loss of negativity, which is proportional to the stimulus, is called a *graded response* or *local potential* since it was not propagated to neighboring cells. The importance of the graded potential is that it represents the electrical translation of a mechanical or chemical stimulation and is capable of switching the membrane to the activated state.

If the intensity of the stimulus is increased, the local potential will reach a threshold where the properties of the membrane change completely. The permeability of K+ drops sharply, and the enzymes pumping Cl— out of the cell are activated. The cell loses sufficient negative charges for the membrane potential to change from the classical —80 mV to +80 mV (Shanos, 1986), the inside of the cell is now positive. This is called the *action potential* (Boriss & Libbert, 1984, p. 19), a very important phenomenon which commands many functions in animals and in plants (Pickard, 1973). Soon after the onset of the action potential, the permeability of K+ is restored and the active transport of chloride stops. Large amounts of potassium now leave the cell following the chemical and electrical gradients until the resting potential of —80 mV is reached once again. The K+ and Cl— lost during the action potential will then slowly be taken back by the cell (Boriss & Libbert, 1984, p. 20). For a study into the ionic movements in *Dionaea;* see Lichtner & Spanswick, 1977 cited in CPN 6:74 1977.

It is worth noting that the cell walls of the sensory and neighboring cells are reinforced with water-repellent (hydrophobic) cutin granules (Buchen *et al.*, 1983, p. 463). These structures are well known from *Drosera* and *Drosophyllum* tentacles (Haberlandt, republished 1982, p. 68 and 73; Diels, L., 1906) and *Dionaea* glands (Robins & Juniper, 1980, p. 280), where they prevent uncontrolled movements of water and solutes in the extracellular space. Are these structures purely vestigial here or are they of some use? The sensory hairs derive from the ancestral tentacles (Juniper, 1987). They may prevent the ions and accompanying water molecules lost during the action potential from flowing away, which would make their re-absorption more difficult.

Now, I would like to discuss some insight into the biochemical mechanisms underlying the action potential.

There was a note of surprise when it was shown that the closed traps of *Dionaea* contain a substance well known from primitive animal muscles: *lysophosphatidic acid.* This is an activator of the enzyme phospholipase D, which breaks up (hydrolyses) some phospholipid components of the membrane (Lea, 1976). One of the hydrolysis products is thought to diffuse into the cytoplasm and triggers a massive release of calcium from the *endoplasmic reticulum* (Wibo, 1987). Now the sensory cells of the hairs contain at both their basal and apical poles an extensive arrangement of concentric smooth endoplasmic reticulum surrounding from one to four vacuoles containing polyphenols (Buchen *et al.*, 1983). Both structures are known storage places for calcium (Buchen *et al.*, 1983, p. 465-466; Boriss & Libbert, 1984, p. 89).

Calcium and magnesium play a major role in the control of enzyme activity, and it was shown that both ions determine the amplitude of the action potential in *Dionaea* (Jacobson & Stuart, 1974 Cit. CPN 4:20 1975). Calcium may be needed for the opening and closing of the channels through which chloride ions are pumped out of the cell (Guyton, 1966, p. 62). Magnesium is probably necessary for the pump enzyme to bind to the fuel which allows it to function: adenosine triphosphate (ATP) (Boriss & Libbert, 1984, p. 303).

The action potential in plants is a rather sluggish affair that is temperature dependent in the refractory period and lasts about one or two seconds (Lloyd, 1942, p. 186-187; Pickard, 1973; Williams, 1980). In comparison, animal nerves have a duration of 1-2 milliseconds (Guyton, 1966, p. 66; Vander *et al.*, 1970, p. 140).

If the cells of *Dionaea* have not restored the normal resting permeabilities, then an action potential cannot be produced. This is called the *refractory period* and it has interesting consequences (Vander *et al.*, 1970, p. 145). If a sensitive hair is touched twice in rapid succession, then the second stimulus will not trigger an action potential (Macfarlane, 1902),

for the sensory cells will still be in their refractory period. This may be of some use to the plant in decreasing the risk of unnecessary closure by the single stroke of a windblown particle or a raindrop, although the latter appears to be a frequent cause of closure (Williams, 1980). If there are two well-separated stimuli, it's likely that prey is moving inside the trap.

The action potential has another interesting property. Not only does it allow the sensory cells to react to the presence of prey, the activated state of their membranes will be *transmitted* from cell to cell until it reaches the tissue responsible for trap closure. When the extracellular fluid becomes negative during the action potential, electrical currents appear which tend to depolarize the fluid surrounding neighboring resting cells. But electrophysiological calculations show that because of the thickness of intervening walls, the cells are too far apart for this depolarization to trigger an action potential. This transmission presumably occurs through small cytoplasmic tubes connecting the cells, called *plasmodesmata* (Mackie, 1970 cited in CPN 1:13 1972). At this level, the membrane of the cell is continuous with that of its neighbor. Plasmodesmata are especially abundant between the sensory and podium cells of the sensitive heir (Buchen *et al.*, 1983, p. 463 and 467), and presumably also link together all the epidermal cells. The different densities of plasmodesmata over the surface may explain why diffusion of action potentials is more rapid in the direction perpendicular to the midrib, and faster also in the inferior, abaxial epidermis (Pickard, 1973 citing Burdon-Sanderson).

Each time a sensitive hair is stimulated, the action potential will diffuse over the trap surface like a ripple on a pool with a velocity of 6-17 cm/sec (Luttge, 1985) or 10-20 cm/sec (Williams, 1980, p. 75). It will spread over the area of a typical trap in 0.25 seconds (Williams, 1979 in abstract of Takao Sibaoka).

How does the action potential get from the hair and superior epidermis to the lower side of the trap? It probably cannot go through the parenchyma, which is too loose and does not seem to have sufficient plasmodesmata. The depolarization probably goes around the rim of the trap. Already we saw that rubbing the marginal teeth may produce closure, so the epidermis on the edge of the trap must indeed be electrically connected to the abaxial epidermis. There's an intriguing remark in one of Darwin's letters about his being able to block the spreading action potential to the opposite lobe by inflicting a small incision (Godbout, 1978). This would imply that the signal can't cross the abaxial side of the midrib and the parenchyma of the trap.

Finally, it should be noted that the action potential gives rise to a response that stays the same regardless of the strength of the stimulus. This is known as the *all-or-none response.* Once we acquired an understanding of how *Dionaea* detects the presence of prey in the trap, we now can turn our attention to the next act: the closure of the trap itself.

Basically, the trap closes because of very fast growth of the epidermis. What does this imply at the level of the cell walls? Water molecules are constantly moving due to random thermal agitation and a certain fraction of these will cross the cell membrane. Now the cell contains many chemical substances dissolved in its water so that the inside of the cell contains fewer water molecules in a given volume than in the extracellular space. The result is that there is more water moving into the cell than leaving it, and if nothing is done, the cell will swell up and burst. To control this *osmotic flow*, plant cells surround themselves with a resilient cell wall built up of macromolecules (Vander *et al.*, 1970, p. 53). These are linked together by strong covalent and weaker hydrogen bonds. An example of the latter are calcium-bridges between carboxyl groups of protopectin molecules (Boriss & Libbert, 1984, p. 354). When the osmotic inflow of water distends the cell wall, there will be a build up of pressure which will ultimately prevent excess water from entering the cell. When an individual cell needs to grow to cause closure of a VFT, the wall itself must be allowed to soften and expand first. Experimental evidence suggests that acidification of the wall plays a major role here. Indeed, flooding a trap with acid buffer causes closure (Williams & Bennett, 1982). Although the exact mechanism is as yet unknown, the concept itself was recently criticized (Dorffling, 1986).

It is thought that the acidity activates wall enzymes which cut covalent bonds between the protopectin and elastin of the matrix and maybe even bonds involving cellulose (Progress in Botany 44: 188 1982). It is also surmised that enzymes assume their active condition when an excess of hydrogen ions displaces calcium ions which formed bridges keeping the enzyme molecules folded up. It was shown that EDTA, a calcium-binding substance and chelator mimicks acid growth (*ibidem;* Hock, 1984). Another theory suggests that calcium-bridges of the cell wall itself may be broken by the acid pH (Progress in Botany 44: 188 1982). However, acidification of both epidermis surfaces would then cause overall growth of the trap rather than closure (Williams & Bennett, 1982).Closure is caused when only the outer (lower) epidermis expands (due to cell growth) while the inner surface remains relatively rigid. Re-opening of the trap requires reversal of this process.

When the enzymes break up the crosslinks between macromolecules, the wall becomes visco-elastic. This means that it can stretch, but it does not return to its original shape (Boriss & Libbert, 1984, p. 142). The molecules slide past each other and new crosslinks are formed between chemical groups facing one another. One will guess by now that the action potential will cause the membranes to pump acid into the wall which loosens it and allows it to lengthen (Williams & Bennett, 1982, p. 1120). Just as the pumping out of chloride ions provokes the inversion of membrane polarity during the action potential, the secretion of acid consumes a large amount of cell fuel, namely ATP. It was shown that 29% of the total leaf ATP is used up in 3 seconds during closure. Since most of the trap tissues are inactive, the proportion of ATP burned up in the external epidermis may be close to 100% (*ibidem,* p. 1121).

Other experiments confirm the importance of ATP. Exogenous ATP fed to the trap enhances closure rates. Illuminated traps produce more ATP through photosynthesis and close faster than traps kept in the dark. Pure oxygen increases the respiratory production of ATP, and the opposite is true for plants grown in pure carbon dioxide (Jaffe, 1973). The significant loss of ATP also explains why plant traps that are too frequently stimulated tend to become sickly and die (Brown, 1916, p. 76). In its native environment the plant sacrifices a significant amount of ATP to obtain scarce elements like nitrogen which it has no other way of getting. Each unnecessary closure wastes a third of the precious cell fuel and weakens the plant. In the abaxial epidermis, the active transport of hydrogen ions into the cell wall seems to replace the loss of K^+ which elsewhere reestablishes cell negativity during the refractory phase of the action potential.

All these activities for trap closure are very much temperature dependent. At high temperatures of 40° C and even at 35° C about half of the time the hydrogen ion outflow produced by *one* action potential seems to be sufficient to bring the cell wall acidity down to the enzyme optimum activity. Experimental evidence shows no enzyme activity at pH 5.0, slow and irregular closure at pH 4.5, rapid closure at pH 4.0 which is the optimum, and slower closure at pH 3.0 (Williams & Bennett, 1982). This seems a likely explanation of the results. At usual temperatures, two action potentials are needed to move enough hydrogen ions (Macfarlane, 1902).

The need for two stimuli brings up two interesting consequences. The second stimulus cannot come too quickly after the first because of the refractory period (Williams, 1980, p. 77). If two hairs are touched almost simultaneously, the two fronts of the action potential all cancel where they meet, the opposite cells being in their refractory phase (Williams, 1980, p. 77). If the second stimulus comes within 20 seconds of the first but after the refractory period, the action potential will have a shorter rise and will travel twice as fast as the first (Williams, 1979-review of Sibaoka, 1979). Presumably some of the effects of the preceding depolarization still linger on; maybe the re-uptake of calcium ions by the endoplasmic reticulum was not completed and more chloride and hydrogen ion pumps will be stimulated during the second potential (Hock, 1984, p. 155).

When the interval between stimuli is increased, not only will the re-uptake of calcium be completed, but increasing amounts of hydrogen ions are taken back into the cells. The pH
Please see **MECHANISM** on page 91

A Further Note on *Nepenthes rajah* Cultivation

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It has been several years since I wrote "On the cultivation of the Giant Malaysian Pitcherplant, *Nepenthes rajah*"(see CPN 12 (4): 82-84. 1983. Here I report that my plants are not only still alive but growing ever larger (Fig. 1). The estimate of 4 years from seed to maturity in my first article seems a bit small now. I strongly suspect they require 7-9 years under the best horticultural conditions. During the last 3 years I devoted my energies to other matters and my plants have endured rather than prevailed.

Basically, since the first paper, I have found that this endangered plant species is not so exacting in its requirements. Misting is not essential, but if provided, is most beneficial. At times my plants have sat in standing water. I believe their root systems have shrunk as a result. Flow-through water from above is still best for a vigorous root system.

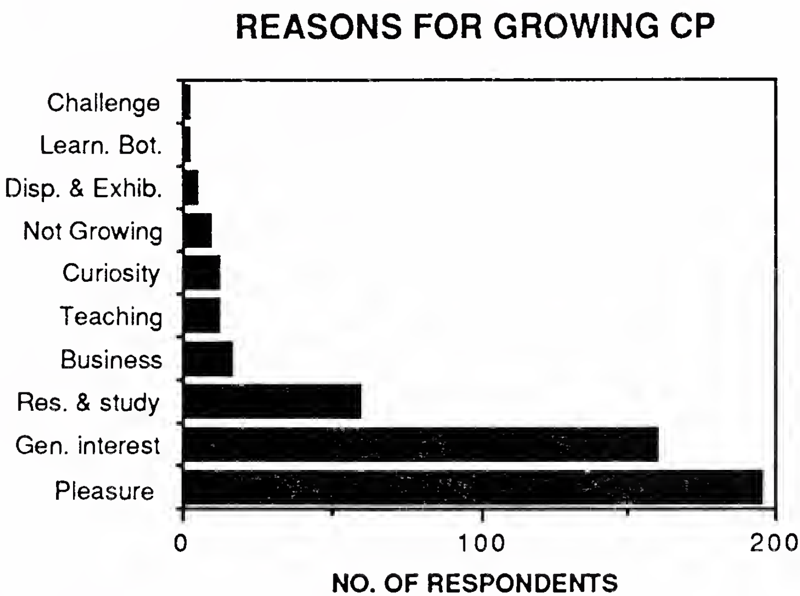
I have no doubt that this species can reach 8′ tall as a clump of 4-5 stems each 2.5-3″ across (and dropping huge crimson traps from each leaf). I have seen a stem diameter over 2.5 inches across on a herbarium sheet of this species. I suspect even the most plegmatic horticulturist can be moved to ecstatic exclamation when he sees the first plants reach these dimensions.

Lower pitcher of *N. rajah* grown by author.

CPN READER SURVEY RESULTS by DONALD SCHNELL
(continued from June, 1988)

Question 6.

This was a complex three part question in which we asked why you grew CP, favorite species you are growing, and species you would like to grow. The results are tabulated below. In some parts or the entire question, there were no replies. Others gave multiple reasons and/or species. Some respondents volunteered that they were non-growers.



Comment—

Pleasure was the overwhelming reason for growing CP, and many of these people listed one or more additional interest combinations. A spreadsheet "all combinations" presentation of these would be too space consuming. I found the numbers of people doing some sort of research or study and using the plants for teaching interesting. Readers may note additional interesting conclusions as well.

Favorite species now growing—

Nepenthes—64
Sarracenias—41
Droseras—33
Dionaea—26
Heliamphora—14
Cephalotus—14
Darlingtonia—10
S. purpurea—10
S. leucophylla—6
Pinguiculas—6
S. flava—5
D. capensis—5
Utricularias—4
Byblis—4
D. adelae—3
N. rajah—2
D. binata—2
S. minor—2
S. rubra ssp. *jonesii*—2

Also one each for *N. villosa, N. lowii, N. ventricosa, N. mirabilis, N. gracillima, N. rafflesiana, N. edwardsiana, S. psittacina, S. rubra* ssp. *wherryi, S. rubra* ssp. *alabamensis, Genlisea, D. capillaris, D. madagascariensis, D. peltata, D. prolifera, D. intermedia, D. macrantha, D. regia.* Thirteen people replied "Like them all" or something similar.

Comment—

Obviously, the pitcher plants, sundews and Venus flytrap are far and away the favorite plants, or at least in a list of favorites—Many people listed several they could not further reduce, which we understand. These results will help us in planning material for future issues, *but* we will try and make the issues sufficiently well rounded that species of lesser interest will not be ignored. Of course, a lot depends on what material you send us to put into CPN.

Species you would like to grow—

Heliamphora—36	*N. villosa*—6
Nepenthes—34	*Aldrovanda*—5
Darlingtonia—23	*Pinguicula spp.*—5
N. rajah—19	*Roridula*—4
Cephalotus—17	*Triphyophyllum*—4
Drosera—7	*S. leucophylla*—3
D. regia—7	*N. lowii*—3
Sarracenia—6	*N. bicalcarata*—3
B. gigantea—6	*Genlisea*—3

In addition, there were one or two votes for 31 more species which we cannot list here. Two growers said "All of them!", and "Only one? Are you kidding?". Several people mentioned special problems maintaining *Darlingtonia* and *Cephalotus* because of the summer heat in their growing areas. Most of the Pinguiculas listed were Mexican or South American.

Comment—

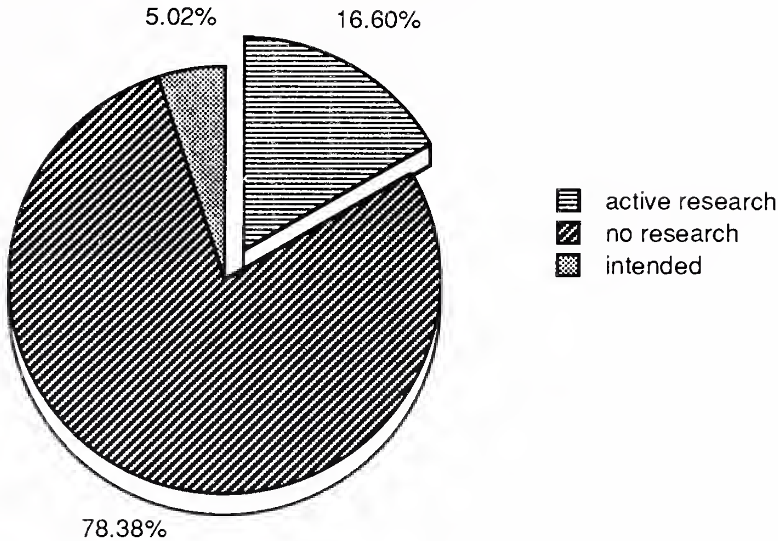
Again, the "wish list" favored rare spp. (eg *Heliamphora*—rare in collections, that is) or *Nepenthes* spp. After that, there was quite a spread. The readers seemed to express equal interest in sources of these plants, proper growing facilities for them, and/or instruction on growing them. A perusal of a collection of current CP catalogs indicates that most genera are listed, along with many "rare" spp. Also, where transport is legal under conservation constraints, trades and sales between growers may be arranged through our want- ads section. If anyone has more growing tips on how to manage more difficult species, send them on in to us! Finally, new subscribers may benefit from the ten years or so of back issues of CPN available—They have a great wealth of information stored in them.

Question 7.

(Publishable research activity)

Not all respondents answered the question yes or no, but 43 (17.5%) replied that they were engaged in some CP research project. Of the remainder of those replying, 203 (82.5%) said they were involved in no active research, but 13 (6%) said they intended to. Some of those who wrote in comments stated they were involved in non-CP botanical research, but of course they were not counted.

QUESTION 7



Comment—

The nature of the research projects (when comment was made) varied from supported institutional research to personal projects. We regard all as important and would like to hear publishable summaries from you when possible.

Question 8.

(Would like more or less in CPN of which genera or species)

We have to apologize for the misspelling of *genera* (general) in the questionnaire, but most people caught on. Fifty respondents stated that the balance of genera or species was fine as is without further comment. The rest of you listed what you would like *more* or *less* emphasis on as follows:

MORE

Nepenthes—42
Drosera—39
Utricularia—24
Heliamphora—23
Sarracenia—23
Pinguicula—17
Dionaea—10
Cephalotus—8
Genlisea—4
Darlingtonia—3
Brochinea reducta—3
Byblis—2
Aldrovanda—2
one each *Roridula, Triphyophyllum, Drosophyllum, Capsella* and CP plant associates.

LESS

Nepenthes—16
Sarracenia—6
Hybrids—6
Utricularia—2
One each carnivorous fungi and Pinguiculas.

Comment—

Many people did not answer the question, or only answered the "more" or "less" part alone. There were some very general comments such as more "North American, Australian, rare plants, conservation, etc.". When tabulating these results, I noted the obvious collective emphasis placed on the "more" over the "less", an interesting positive attitude, I suppose. The heavy favorite for more is our old friend *Nepenthes*, the heavy interest in Utricularias and Pinguiculas being mostly the tropical species with particular interest in photos. Those readers who have good, clear photos of such species that have not yet appeared in CPN or not appeared recently may wish to send them in.

Question 9.

(More or less emphasis on general categories)

Of the respondents, 35 answered that they were satisfied with the balance as is without further comment. Many of those who suggested more or less of something also expressed a general satisfaction, but with their caveat.

MORE

Horticulture/Propagation—158
Field trips/observations—62
Plant descriptions—53
Conservation—35
Research papers—34
Color photos—25
Young people's and beginners column on CP and botany—12
Tissue Culture—9
Artificial light/chamber growing—5
Sources (books, plants, seed)—4
People information—3
Greenhouse growing—2
CP shows—2
Members list—2
one each CP articles from other CP publications, Products, more extensive literature reviews, monographic issues.

LESS

Technical/research papers—27
Field trips/observations—14
Plant descriptions—10
Conservation—6
Horticultural—4
Reviews—3
Plant show reports—1

One fellow wanted comments from growers on what their wives thought of the hobby! We could be getting into the middle of something there.

Comment—

Those who encouraged more field trip/observations reports wanted to see more technical aspects such as ecology, habitat, soil analysis, etc., and less travelogue. A few specified that they enjoyed the travelogue aspect. Those who mentioned the young people's/beginners and basic botany corners we had for awhile wondered what happened to them and they missed them. All in all, we have a pretty broad mandate here and it seems like a broadly mixed yearly volume might be the best answer to meeting it. Again, as was the case with the genera and species in question 8, more people responded to *more* than *less* which we take as serious constructive suggestions.

Question 10.

This was our open question where readers could make final comments. We suggested responses to the name of the publication and possible changes there, and also comments on the general direction of CPN. Of the respondents, 66 said that they felt CPN was on the right course and had no further suggestions. Several people did not answer the question at all except for the question of name. The results of what our publication should be called listed in decreasing order are: Keep CPN—119, Journal—50, Bulletin—7, put "international somewhere in name—2, Quarterly—1, and some more formal name not specified—6.

It seems overwhelmingly that CPN is a favorite. Many reasons were given from "why change, ok, content is more important, etc.". However, many people wrote that they felt "CPN" meant something in terms of an institution and readily recognized entity even if the quality was more of a journal or bulletin. They decried any tendency toward more formality and liked the mix of some pretty stiff stuff with lighter material. Those pushing for the more formal names (eg journal and bulletin) emphasized that we were no longer a letter, that the contents deserved a more formal connotation which in their view was more accurate, and that the name would attract more attention in the world of academics and possibly more formal contributions.

So there you have it. Both arguments seem sound in their points and we will have to think long and hard on this one. The usual course is that if a change does not seem urgent and a majority (overwhelming here) want the original name, to follow the conservative course and keep it.

Now, some of you did mention other things. Seventeen people (and more elsewhere in the questionnaire) mentioned the lateness of issues, and as I said previously, we have no viable excuse for that and we must make an effort to get issues ready on time. Fifteen people mentioned that they would like to see larger issues more frequently in the year. This would depend on funds, material contributed and numbers of subscribers. A recurrent theme throughout the questionnaire was a mention of conservation and here at the end ten people made pleas for more emphasis on conservation and the results of conservation efforts reports as well as instances where conservation efforts were too late. We are pleased to see this interest as conservation efforts toward CP in general are on the increase and are getting more press, about time in this writer's opinion. Nine people mentioned the possibility of organized local or regional chapters with meetings, plant shows and exchanges, etc., and even a national meeting if possible. As you know, CPN is the official publication of the ICPS which still needs officers and an organizational setup to get some of these things going. Single mentions were made of a table of contents, punching holes in the bound margin for ring binders, a less garnish cover with the bright colors eliminated around the lettering, photo contests, and suggestions for improving the next survey (well taken!).

Conclusions

I feel this survey has been of great value and you can be assured that we will consider and digest all this material and try to come up with something that may please as many of you as we can. While one issue obviously cannot contain everything everyone wants, we should be able to get a good mix over a volume or two of four to eight issues so that the publication seems worthwhile. Furthermore, since many of you gave multiple responses to many of the list questions, and you have a general interest in nearly all CP, you can still get something out of any one issue. This depends, of course, on one primary factor—You send material in to be considered for CPN. We cannot publish without material.

Other important items include a clear effort on our part to get issues out on time. Confusion, uncertainty and a loss of morale result when one of your favorite publications is consistenly late. The problems lie in several areas: slow printer work, lack of a secretary at

the moment, irregular volume of material, lack of prompt proofreading so the printer can proceed, etc. We will work on all of these.

Another important general theme in your answers seems to be support of young people and beginners. It goes without saying that this should also be a primary mission. We will look into resuming the Beginners' and Botanists' Corners, and starting a Young People's Corner. At the same time, each issue must contain more advanced and specialized material as well to serve our more experienced readers and to challenge our new and young readers who can always look back over older issues and be able to interpret something that was published before that was once beyond them but is now fathomable.

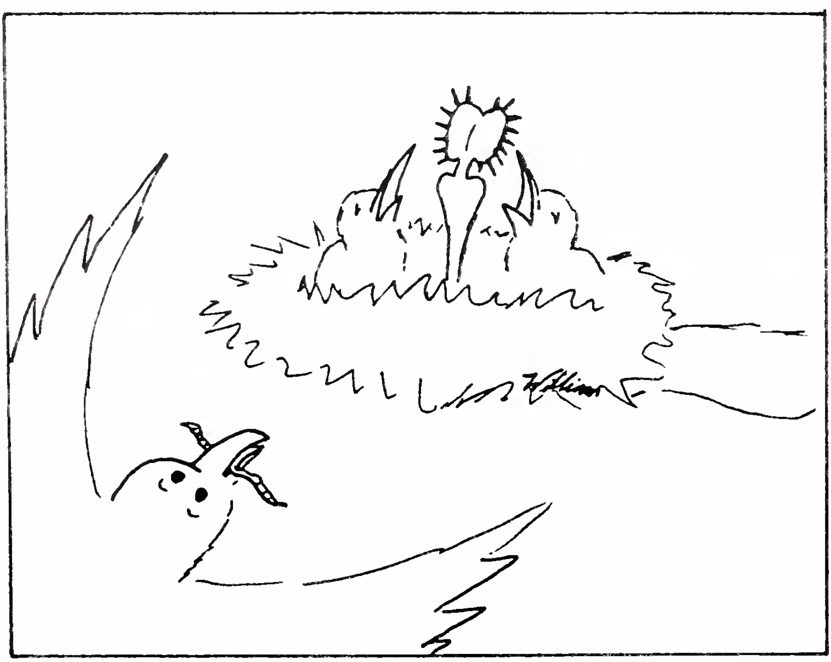
The request for some sort or meetings, be they regional chapters or national or both, has been a longtime one. As we mentioned above, these require considerable organization and most likely a committee (I mean a truly active one, not one of "those" committees) could be established to set this up. Any volunteers?

You seem to want the quality product that CPN is today, and the name. I think that the best editorial course is to try to the best of our ability to make each issue or one or two issues as much a mix of your wants as possible. Since the "more" lists were longer and outnumbered the "less" lists, it would seem sensible to follow this course, and to look into reestablishing the separate columns mentioned above.

All of us co-editors thank you again for your considered responses. We will keep doing our best to bring you a good, useable publication. But we will need your help.

Tidbits

from Bill Strand



MECHANISM continued from page 83
drop following the second action potential is not sufficient to reach the optimum pH of the wall loosening enzymes long enough for the growth to take place. The result is partial closure of the trap and a series of stimulations are needed to obtain complete closure (Brown, 1916). There will also be problems with dwindling stores of ATP, probably responsible for the phenomenon known as "fatigue." Each action potential is slower and less efficient than the preceding ones *(ibidem).* Sickly plants have insufficient ATP and the closure of their traps is sluggish. Since the number of stimulations necessary to close a trap increases with the time interval between them, it seems that at 170 minutes every trace of the preceding action potential has disappeared, and all of the hydrogen ions are taken back with the result that a stimulus at that moment will not contribute to closure (Williams & Pickard, 1979).

The actual driving force for cell lengthening is the osmotic inflow of water into the cells of the external epidermis. This becomes possible due to the cell wall loosening the usual equilibrium between osmotic and elastic pressures. Intracellular pressure drops, allowing the inflow of water which expands the cell wall until a water shortage appears. If cell pressure is increased by firmly holding the trap lobes apart, then closure is very easy to prevent (Schultz, 1965, p. 97). By the end of closure, there will be a localized water shortage. The external epidermis will appear flaccid and the water pressure in the leaf will drop by 0.51 bar in one experiment (Williams & Bennett, 1982).

Regulatory mechanisms will come into action. The internal epidermis will adapt to the water shortage by decreasing its osmotic pressure. Sugar molecules will be joined into starch. Amyloplasts will be observed in cells 15 minutes after trap closure (Brown, 1916, p. 79-80). The external epidermis must prevent its cytoplasm from being diluted by water inflow so the excess is pumped into the central vacuole (Boriss & Libbert, 1984, p. 509). After 15 to 20 minutes the water pressure in the leaf has returned to normal and with the crosslinks established, the normal elasticity of the cell walls is restored. At that moment, the experimental suppression of osmotic pressure is unable to cause the trap to re-open as happens if this same experiment is done immediately after closure (Brown, 1916, p. 78).

Everybody knows the famous biology class experiment where a VFT is anesthesized with ether vapours and the trap fails to close after stimulation of the sensory hair. This can be explained by the ether blocking the membrane pumps and thus preventing the action potential. If ether is used on a closed trap, the lobes become floppy and the trap is easy to re-open. I use this trick to observe VFT surfaces under the microscope without them curling up all the time. The ether probably blocks the membrane pumps involved in osmoregulation, preventing the cells of the abaxial epidermis from maintaining the concentrations of solutes within bounds. This is usually done by pumping the excess water into the central vacuole and the uptake of extracellular ions (Boriss & Libbert, 1984, p. 509).

The amount of actual growth varies enormously. The cell lengthening is maximal in the center of each lobe-about 28% (Williams & Bennett, 1982). Other experiments yield rates between 0 and 30% (Brown, 1916, p. 71). A trap may be made to close for a number of times, but each successive time the growth will be less pronounced *(ibidem,* p. 76 with successively 13, 9, and 3.2% per closure). Other factors such as temperature and the health of the plant play a role. Mechanical closure (incomplete? may be obtained 7 to 10 times (Batalin, 1877 cited in Lloyd, 1942, p. 190). If digestion takes place each time, then reopening after the third closure will be slow and the trap usually dies while trying to digest the fourth capture (Schultz, 1965, p. 97). The lesser number of closures may be due to the additional use of ATP for digestion.

One major question remains on why the action potential which reaches both the internal and external epidermis only affects the external epidermis growth. In the experiment with the acid buffer, the trap closes even though the acid enters both tissues. A selective acidification of the cell walls of the abaxial epidermis does not seem to be the explanation. An unstimulated trap does grow, but much more slowly than during closure of course: 3.1% in 18 days; 1.4% and 9.6% in 7 days in three of Brown's experiments (Brown, 1916, p. 74-76).

This shows that cell wall loosening enzymes must be present in both epidermal surfaces because they must both grow, otherwise the trap will close. Measurements after closure show a total absence of growth in the abaxial epidermis *(ibidem,* p. 73). It is concluded that the action potential strongly stimulates growth on the abaxial side of the lobes, while blocking the enzymes on the inside of the trap. Whether the specificity of the epidermis is brought about by the influence of light, of gravity, or by phytohormonal gradients remains to be established.

The trap becomes a small cage immediately after closure. The marginal teeth are interlocked and almost perpendicular to the plane of the lobes. They form the bars of the cage (Lloyd, 1942, p. 193). They often allow small prey to escape so as to avoid wasting the ATP necessary for digestion of low amounts of nitrogen. In cultivated plants, even large prey are sometimes observed getting out of a trap. One may think this is related to the plant's health, but even in nature escapes are common. (40 to 60% of captures in the field study conducted by Williams, 1980, p. 75). The relative water shortage in the external epidermis just after closure and the fact that all the cell wall crosslinks are not restored make this a critical moment for the trap. Many a prey manages to push apart the floppy margins to flee.

Inside the trap the internal epidermis of the two lobes are not in actual contact. The captures tend to move around unceasingly, touching the sensory hairs and causing hundreds of action potentials (Dubosky, 1975; Affolter & Olivo, 1975). These result in a certain amount of slow growth tightening the closed trap (Lichtner & Williams, 1977, p. 884). Eventually, the internal epidermis will come into contact except near the midrib *(ibidem* p. 886). Large prey may be crushed during this narrowing phase which may take from 30 minutes to 12 hours (Lloyd, 1942, p. 189; Schultz, 1965, p. 96; Lloyd, 1942, p. 178). Small captures like ants stay alive in the midrib region. They will only be killed when the secretion of acid digestive fluid begins 5 to 11 hours after closure (Lichtner & Williams, 1977, p. 886). From that time on, there will be no more action potentials and other mechanisms become responsible for maintaining trap closure (Affolter & Olivo, 1975 cited in Lichtner & Williams, 1977, p. 885).

If a trap is closed by mechanical stimulation, there are no action potentials after closure, no chemical stimuli, no narrowing phase, and the trap soon reopens (Lloyd, 1942, p. 193). This shows that chemical stimuli continue to play a major role, even with similar results as action potentials. Actual closure occurs if moist organic matter is deposited on the internal epiderm without triggering the hairs. The movement is nowhere as rapid as after mechanical stimulation, though the narrowing phase will be induced after mechanical closure if adequate chemicals are left inside the trap (Lichtner & Williams, 1977, p. 884-885; Schultz, 1965, p. 96). A trap will remain closed as long as it is perfused with those same substances. In these three experiments above, no action potentials are recorded apart from the ones associated with initial mechanical closure (Affolter & Olivo, 1975 cited in Lichtner & Williams, 1977, p. 885). A three percent solution of saline causes a series of action potentials of abnormal amplitude and duration for several hours sometimes (Balotin & Di Palma, 1963 cited in Lichtner & Williams, 1977; Shanos, 1986). This will be due to osmotic or chemical damage to the cells (Lichtner & Williams, 1977, p. 885). Reports that leaf extracts and insect exudate cause *action potential-mediated* closure must be verified (Balotin & Di Palma, 1963 cited in Shanos, 1986). The exact mechanism of chemically induced closure remains unknown. If a prey is crushed during the narrowing phase, the sodium ions in its haemolymph will be a powerful stimulant. The amino acids glycine and lysine are less important but probably do play a role. Saltfree albumin, glucose and potassium chloride are inefficient as stimulants (Lichtner & Williams, 1977, p. 885). Some insects, like flies, excrete a great deal when caught, and this may act as a stimulus also *(ibidem,* p. 886).

Other captures, like ants, will not produce organic fluid except maybe the formic acid they spray around when frightened until they are being digested *(ibidem,* p. 886). Ammonium ion, a decomposition product, is a potent stimulant, probably relaying the action of the preceding substances as digestion progresses *(ibidem,* p. 885-886). Because the epidermal cell's cuticle is impermeable, the only way chemicals are able to enter the leaf is

through the glands. From there, experiments with radio-labelled substances show them to be distributed throughout the plant. The external epidermis gets twice as much as the adaxial epidermis (Luttge, 1965, p. 336). The external epidermis has to complete its cytoplasmic growth after the longitudinal growth which took place during closure. How the growth of the adaxial epidermis prevents being inhibited by the presence of organic matter is still something of a mystery. It is fairly certain that phytohormones play a role (Lichtner & Williams, 1977, p. 886). Topical use of growth hormones causes trap closure, which lasts for at least 48 hours. The same variations of subepidermial liquid pressure as we mentioned following the action potential are observed here (Kondo & Yaguchi, 1983 cited in CPN 12: 75 (1983).

Auxins stimulate the hydrogen ion pumps like the action potential. This is one of the mechanisms through which they promote growth (Boriss & Libbert p. 509). But the exact way in which the hormonal balance of the internal epidermis is changed so as to alternatively allow and inhibit its growth, is far from being known yet. After digestion is completed and the products are absorbed (usually after ten days: Lloyd, 1942, p. 178; 7 to 10 days depending upon the type of prey: Schwab *et al.,* 1969; sometimes several weeks: Schultz, 1965, p. 96), the internal epidermis starts growing again (Brown, 1916, p. 73-74; Williams & Bennett, 1982, p. 1121) and the trap reopens.

There is one last strange consequence of the closing and reopening mechanisms: Since these involve growth, the trap on re-opening is larger than before.

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NOTE: Dues for 1989 will be **UNCHANGED**

LITERATURE REVIEW

BRUGGER, J. and **R.** Rutishauser, 1988. Diversity of vegetative development in epiphytic and terrestrial bladderworts *(Utricularia, Lentibulariaceae).* Submission 147, Bot. Soc. Am., UC-Davis, 14-18 Aug. 1988.

This study indicates that the generally held belief that a primordium in *Utricularia* can grow into any organ (stem, trap, rhizoid, flower) is not always true. SEM studies of development from seed to flowering were made of *U. alpina, U. longifolia, U. reniformis, U. pentadactyla* and *U. sandersonii.* Each species is characterized by its own developmental pattern, with variation in certain limits. The developmental patterns in the genus discloses several heretofore unrecognized taxonomically valuable traits, especially in primordial branching patterns.

De RIDDER, F. and **A. DHONDT.** Dynamics of long-leaved sundew *Drosera intermedia* populations at two extremes of a hydrological gradient. Holarct. Ecol. 10(4): 299-307. 1987.

Plants found on a path through a wet heath were compared to those around a pool edge. Low densities were found in both locations because of high mortality of seedlings due to summer drought and cover with algae after heavy rainfall on the path. At the pool site, the seedlings died off due to long-lasting inundation and neither population of seedlings survived to flower.

HAEGGSTROM, C. and **R. SKYTEN.** Two successional stages of the vegetation in a rock-pool in the Aland Islands, southwestern Finland. Ann. Bot. Fenn. 24(4): 311-316. 1987.

In the 1930s, a large rock-pool on Hertronklubb island was mapped and compared to a study in 1981. The rock-pool was once a marsh which changed towards a sphagnum pool and was dominated by *Typha* and now *Drosera rotundifolia.* The rock-pool became a fen-pool.

KITCHING, R.L., A preliminary account of the metazoan food webs in phytotelmata from Sulawesi (Indonesia). Malay Nat. J. 41(1): 1-12, 1987.

In comparing the water bodies contained in bamboo internodes, stump-holes and pitchers of *Nepenthes maxima,* the author studied the food webs in each situation with a census of insects and larvae found in the corresponding water body.

PAGE, O.T., et. al. 1988. Apoplastic and ultrastructural characterizations of the trichomes from the carnivorous bromeliad *Brocchinia reducta.* Submission 110, Bot. Soc. Am. meeting, UC-Davis, 14-18 Aug. 1988.

Electron microscopic studies of the trichomes of this species disclosed that unlike other bromeliad genera, the cap cells of these trichomes remained alive and the cell walls of adjacent cells were in a labyrinth-like arrangement with periodic thin membranes present that had gaps. It was assumed that this unique structure allowed for absorption which was confirmed with lanthanum tracer studies that indicated that the material passed from the cap cells to the leaf mesophyl. Therefore, it is quite possible that these unique, encrypted trichomes are the absorptive site for nutrients. DES

SANTOS, E. The genus *Drosera* in Brazil: 1 A new species. Bradea 4(38): 305-308. 1986

A new species of *Drosera* namely, *D. pumilla* Em. Santos from Mato Grosso, Brazil is conspicuous by its tawny-hirsute inflorescence and size of the scape, up to 4.5cm.

Coming in December

- CP in 3D
- *Sarracenia rubra*